Indicators of Exposure and Risk (The Missing Links?)

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Indicator (EPA)

 "An environmental indicator is a numerical value that helps provide insight into the state of the environment or human health. Indicators are developed based on quantitative measurements or statistics of environmental condition that are tracked over time. Environmental indicators can be developed and used at a wide variety of geographic scales, from local to regional to national levels."

A review... Steps of Risk Assessment

- > Problem Formulation
- > Hazard Identification
- Dose response
- Exposure Assessment
- Risk Characterization

The Role of Exposure Indicators

Exposure indicators are critical to understanding environmental health of a community

Exposure indicators are also essential in the risk assessment process

Uses of Biomonitoring

- Measure amount of chemical absorbed into the body
- Provide a measure of individual or population exposure levels
- > Evaluate health effects
- Identify those at highest risk
- > Track trends
- Guide prevention strategies

Sampling Questions

Are valid methods used?

Adequate number of samples?

Level of detection appropriate?

Laboratory methods assured?

Population Questions

Highly exposed subpopulations identified?

Sensitive subpopulations?

Variability in exposure measured?

Representative sample of the population?

Exposure Data Questions

Are data geographically relevant?

> Are data temporally appropriate?

Relevant pathways measured?

Do data measure trends in exposure?

Ideal Biomarkers

- Be Persistent have a long half-life;
- Be Easily Collected collected using non-invasive procedures that present only minor procedural difficulties in collection, transport, storage, and analysis;
- Be Linked to Disease display exposure, indicate effect, and establish a link between them;
- Have a Large Sample to examine the distribution of the biomarker in the population and to establish links between the biomarker and effect, it is important that the biomarker found in a substantial fraction of the population.
- Have Broad Spatial Distribution and Temporal Occurrence a complete spatial and temporal understanding of the exposure/health outcome distribution;
- Have Sensitivity sufficiently sensitive to give information on differences in populations from different regions and over time scales of interest, e.g., seasonal or long-term, secular trends.
- (Groopman and Kensler 2005; Metcalf and Orloff 2004; Schulte and Mazzuckelli 1991; WHO 1993)

The Exposure Challenge: Where is it coming from?

We still need improved environmental sampling measures

Biomonitoring does not tell us about the source of the contaminant

We need to measure contributions from different sources and pathways

Air levels

Water levels

Soil/dust levels

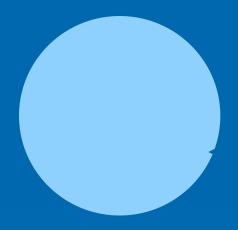
Food levels

Nutritional status

Lifestyle factors

Personal habits

Genetic factors



Measured levels of toxicants in people

MANY OTHER FACTORS

From Exposure to Health Risks

- Environmental concentrations are limited as measures of actual exposure
- Biomarkers provide an important link to dose
- Number of pollutants, mixtures, multiple pathways, cumulative exposure
- Risk assessment is an important step toward measuring health impacts

Application of Risk Assessment Indicators

- Provide a public health context to exposure indicators
- Identify key health endpoints
- Can be compared to health based "bright lines" ... RfD, MCLs
- Provide estimates of community risk
- Risk assessment can guide selection of community health indicators

The Silver Book and Risk

PHASE I: PROBLEM FORMULATION AND SCOPING

- What problem(s) are associated with existing environmental conditions?
- If existing conditions appear to pose a threat to human or environmental health, what options exist for altering those conditions?
- Under the given decision context, what risk and other technical assessments are necessary to evaluate the possible risk management options?

PHASE II: PLANNING AND CONDUCT OF RISK ASSESSMENT

Stage 1: Planning

• For the given decision-context, what are the attributes of assessments necessary to characterize risks of existing conditions and the effects on risk of proposed options? What level of uncertainty and variability analysis is appropriate?

Stage 2: Risk Assessment

• Hazard Identification

What adverse health or environmental effects are associated with the agents of concern?

• Dose-Response Assessment

For each determining adverse effect, what is the relationship between dose and the probability of the occurrence of the adverse effects in the range of doses identified in the exposure assessment?

• Exposure Assessment

What exposures/doses are incurred by each population of interest under existing conditions?

How does each option affect existing conditions and resulting exposures/doses?

• Risk Characterization

What is the nature and magnitude of risk associated with existing conditions?

What risk decreases (benefits) are associated with each of the options?

Are any risks increased? What are the significant uncertainties?

PHASE III: RISK MANAGEMENT

- What are the relative health or environmental benefits of the proposed options?
- How are other decisionmaking factors (technologies, costs) affected by the proposed options?
- What is the decision, and its justification, in light of benefits, costs, and uncertainties in each?
- How should the decision be communicated?
- Is it necessary to evaluate the effectiveness of the decision?
- If so, how should this be done?

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Stage 3: Confirmation of Utility

- Does the assessment have the attributes called for in planning?
- \bullet Does the assessment provide sufficient information to discriminate among risk management options?
- Has the assessment been satisfactorily peer reviewed?

YES

FORMAL PROVISIONS FOR INTERNAL AND EXTERNAL STAKEHOLDER INVOLVEMENT AT ALL STAGES

• The involvement of decision-makers, technical specialists, and other stakeholders in all phases of the processes leading to decisions should in no way compromise the technical assessment of risk, which is carried out under its own standards and guidelines.

Elements of HIA (NAS 2011)

The committee recommended a six-step framework that includes the following elements:

- > Screening
- Scoping
- Assessment
- > Recommendations
- Reporting
- Monitoring and Evaluation

Future Directions

- Our future success will depend upon the development of meaningful indicators for exposure, risk, and health impact
- Continuum of indicators asking the right questions
- Release and emissions environmental monitoring – exposure - risk – community health
- Refinement of indicators for risk assessment and health impact assessment
- Links to prevention, interventions, and policy evaluation

Indicator Linkages

